VDLM2/AGTS Laboratory Validations

Prepared for

Weather Accident Prevention Annual Project Review

Weather Information Communications

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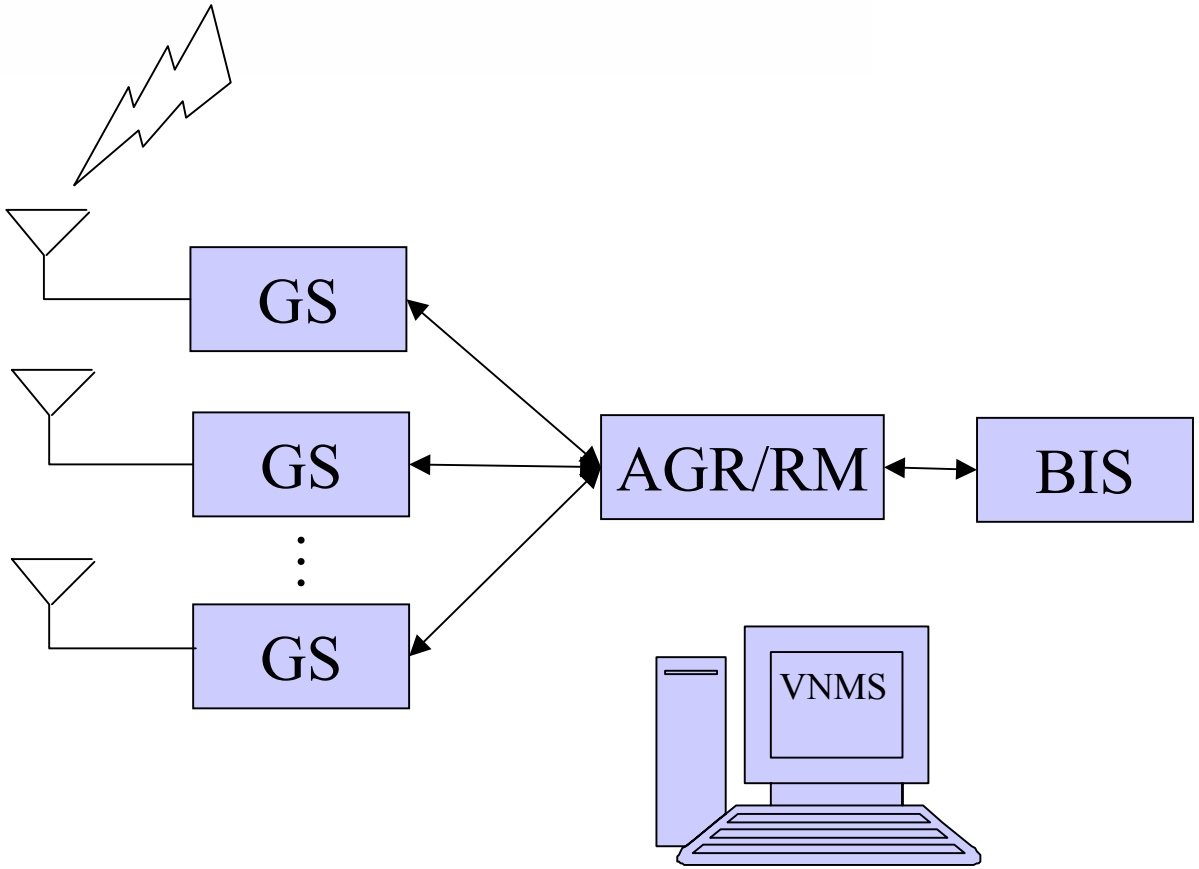
VDL Mode 2/AGTS

- Introduction to VDL Mode 2
- AOA and ATN Services
- CPDLC Application
- Air Ground Test Set (AGTS)
- AGTS's use in testing Weather Applications
- Summary

Introduction to VDL Mode 2

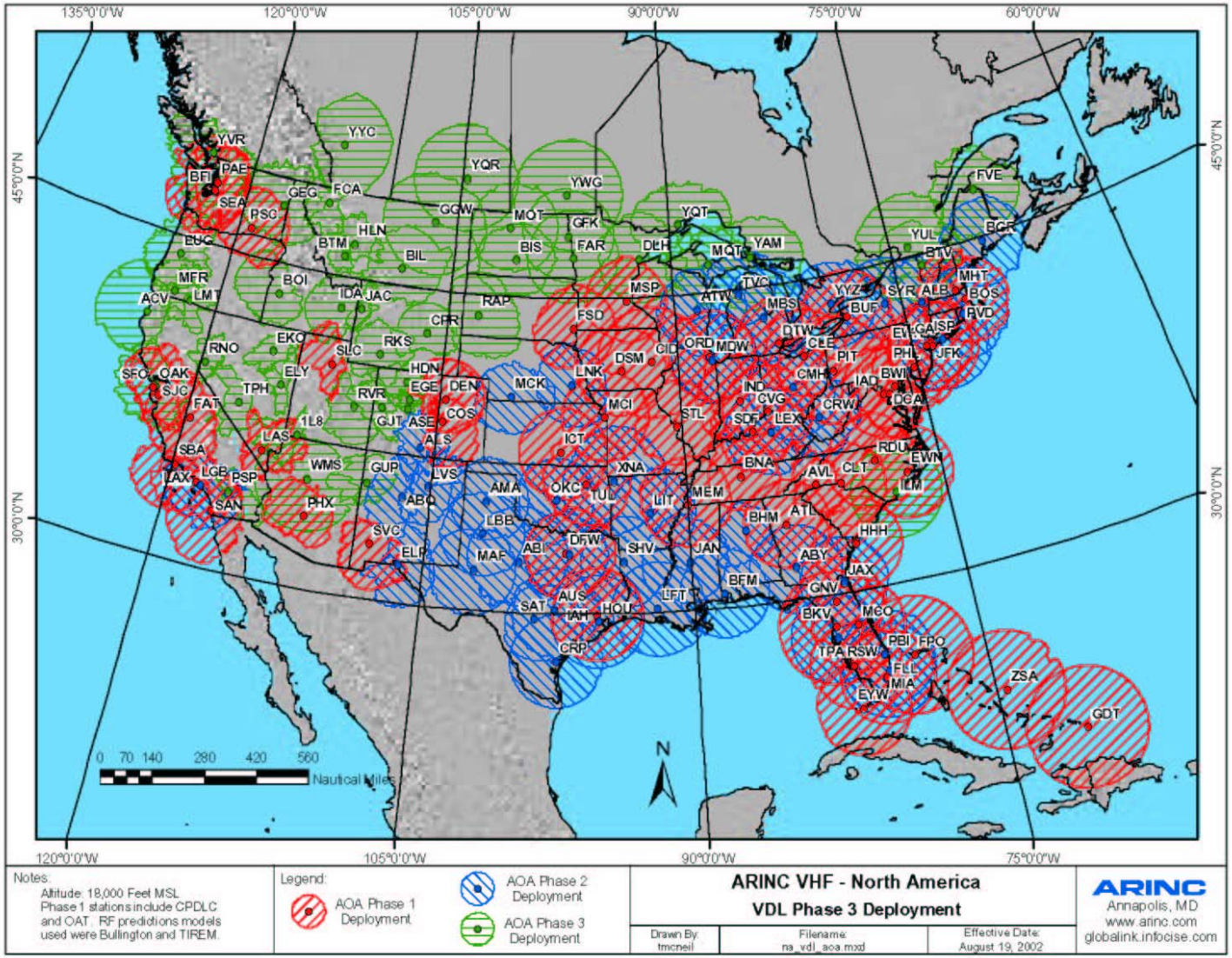
- VHF Data Link Mode 2
- Capable of working on any of the 760 25kHz channels between 118.000 MHz and 137.000 MHz
- Uses Differential 8 Phase Shift Keying modulation
- Raw digital bandwidth of 31.5 kbps
- CSMA protocol controls channel access
- Range limited to line of sight (~200 nmi @ 30,000 ft)
- ARINC's implementation of VDL Mode 2 is a distributed architecture

VDL Mode 2 Distributed Architecture



- Software Architecture uses multi-layer protocol stacks

ARINC VDL Mode 2 Coverage - 2002



AOA Service

- ACARS over AVLC (AOA)
- ACARS achieved a digital bandwidth of 2.4 kbps
- AOA achieves >10 times the bandwidth of ACARS
- AOA allows ACARS applications to take advantage of the increased bandwidth of VDL
  - Supports end-to-end delivery of character-oriented ACARS messages between VDLM2 avionics and ACARS ground hosts via VDLM2 air/ground data link
  - Allows airlines to use existing ground applications and communicate with newer VDLM2 avionics

AOA Message Flow

External Customers

GS

GS

GS

AGR/RM

BIS

AOA Messages

VNMS

VDL Mode 2

ACARS

BEP

Customer's Host

ATN Service

- Aeronautical Telecommunications Network (ATN)
- Supports end-to-end delivery of bit-oriented traffic over an ATN architecture
- Focus application today is CPDLC messaging

ATN Message Flow

External Customers

GS

GS

GS

AGR/RM

BIS

ATN Messages

FAA BIS

BIS

BIS

ATN Messages

AOA Messages

VNMS

VDL Mode 2

ACARS

BEP

Customer's Host

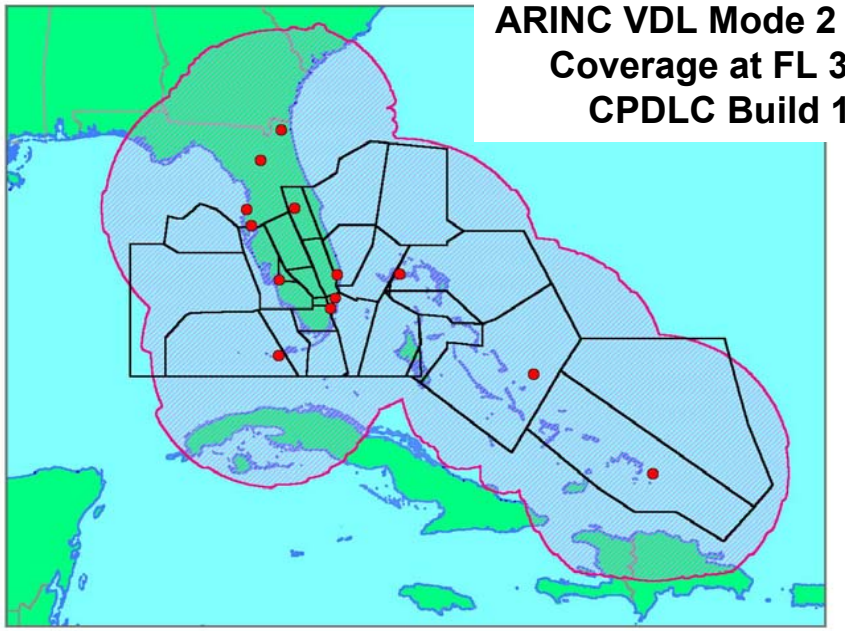
Controller Pilot Data Link Communications (CPDLC)

- CPDLC
  - Air Traffic Control communications via text messages
  - Analogous to instant messaging via the internet
  - For routine and non-emergency communications
  - Voice is always available for high priority
  - Builds on pilot's familiarity with ACARS

- VDL Mode 2/ATN for CPDLC is proven
  - Operational trials in Europe (PETAL II) - 2001
  - Technical validation in USA - 2002
  - Aircraft certification - September 2002
  - Operational in Build 1 Program - October 2002

CPDLC Build 1

- Limited set of pre-formatted, routine messages
  - IC Initial Contact
  - TOC Transfer of Communications
  - AS Altimeter Setting
  - MT Menu Text



ARINC VDL Mode 2 / ATN Coverage at FL 350 CPDLC Build 1

- ARINC is Air-to-Ground Communications Service Provider
- American and Delta (with Rockwell Collins and Teledyne avionics) are confirmed participants as of May 2002

FAA CPDLC Build 1 Program

- FAA program to build, test, deploy, and put into operational service CPDLC over VDL Mode 2/ATN

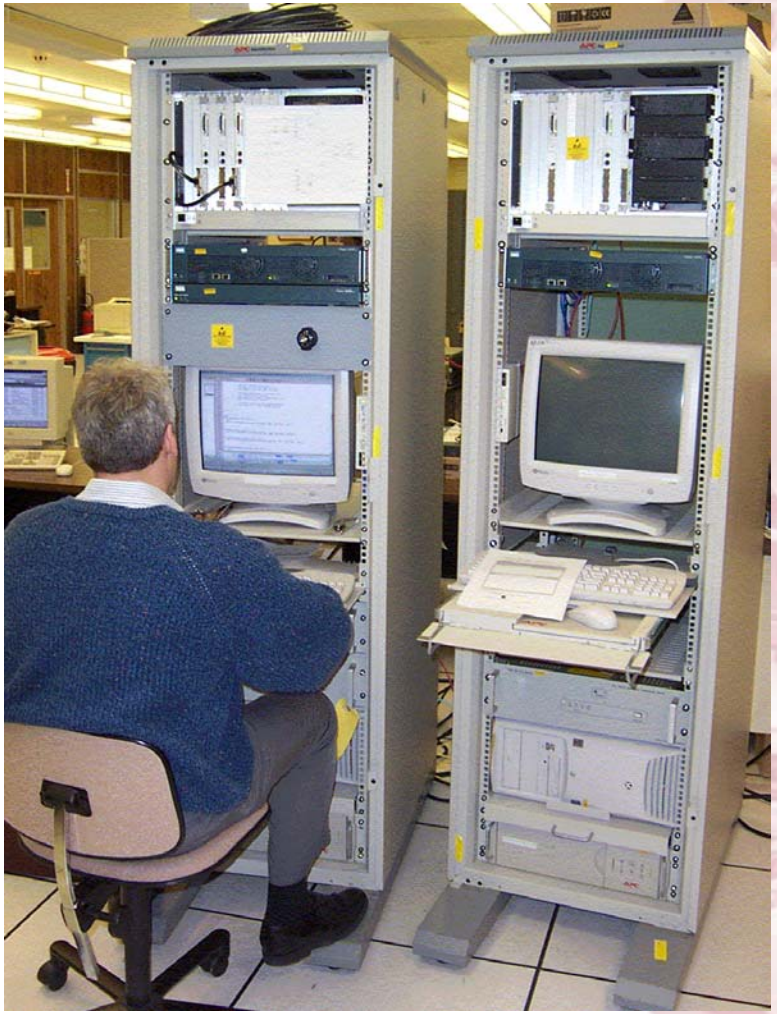
  - One ARTCC (Miami) for en-route traffic
  - Initial Daily Use (IDU) October 2002
  - Operational service until December 2005

An AGTS is …

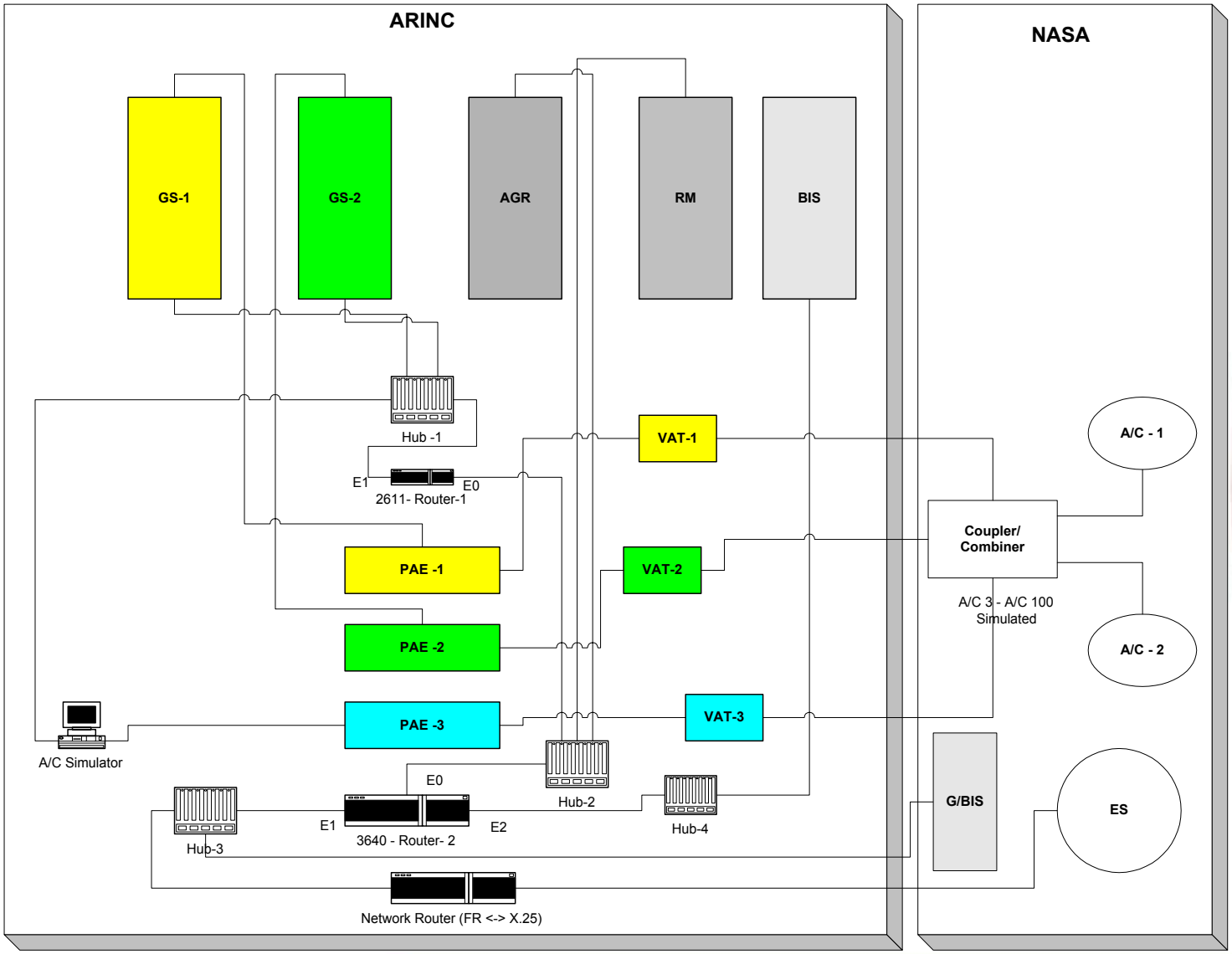
- Air Ground Test Set
- AGTS shares the same HW and SW components as the production VDL Mode 2 system
- Test platform for the VDL Mode 2 communication protocols
- Aircraft simulator
  - AOA aircraft message traffic
  - ATN aircraft message traffic
- BEP Simulator

NASA AGTS

- AOA and ATN service capabilities
- Two GS/VDR combinations
- GS to GS handoff testing
- Aircraft simulator for traffic and self-test
- Primary Components
  - 3 PAE VDRs
  - 2 GSs
  - 1 AGR
  - 1 RM
  - 1 BIS



NASA AGTS

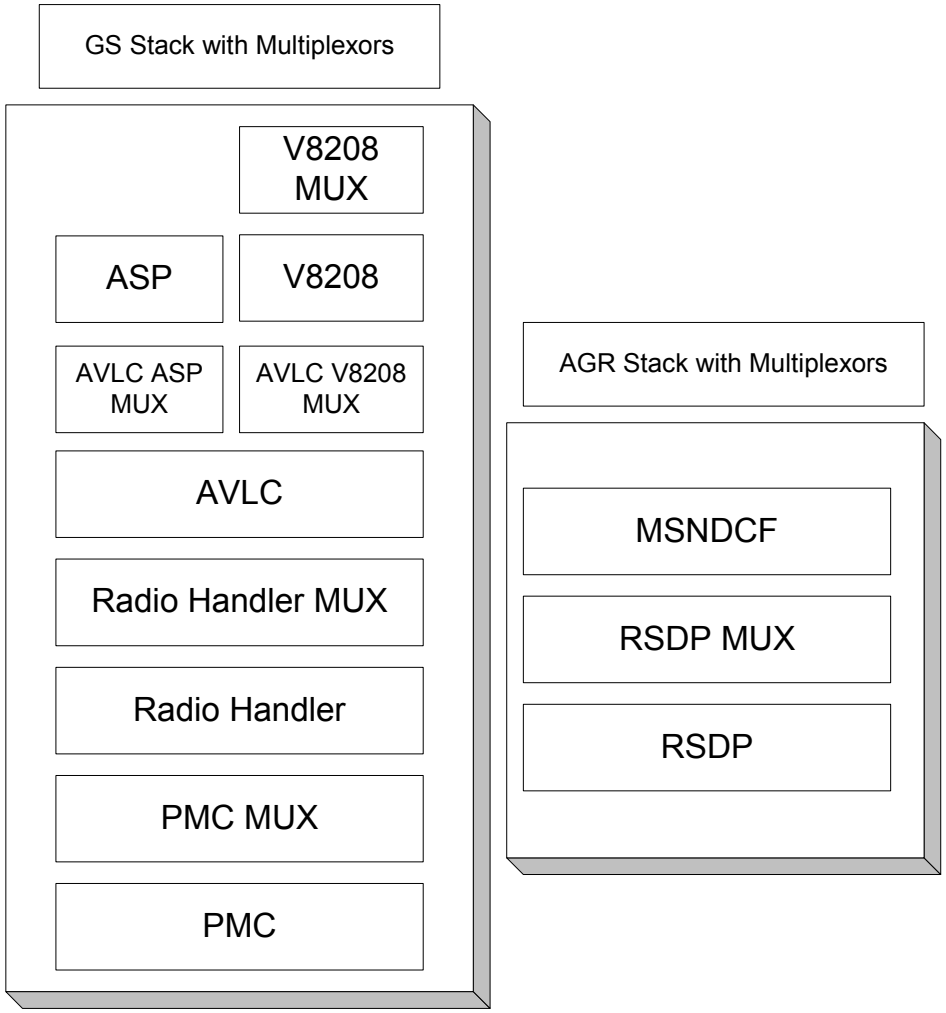

ARINC
NASA
GS-1
GS-2
AGR
RM
BIS
Hub -1
E1
E0
2611- Router-1
VAT-1
A/C - 1
Coupler/
Combiner
PAE -1
VAT-2
A/C 3 - A/C 100
Simulated
PAE -2
A/C - 2
PAE -3
VAT-3
A/C Simulator
E0
Hub-2
G/BIS
ES
E1
E2
Hub-3
3640 - Router- 2
Hub-4
Network Router (FR <-> X.25)

NASA AGTS Test Configurations

- Laboratory
  - RF to RF testing with avionics
  - Handoffs between GSs
  - AOA capability with BEP simulator
  - ATN capability

- Flight testing
  - Connecting an antenna to one of the GS VDRs allows testing with avionics on board aircraft
  - Supports both AOA and ATN message traffic

AGTS Instrumented Protocol Stacks



How has the AGTS been used?

- ARINC – for testing of VDL Mode 2 during development
- Rockwell Collins, Teledyne and Honeywell – as a test platform during avionics development
- ARINC AQP – for testing avionics prior to running on the real network
- NASA – for the Cockpit Security Demo

Cockpit Security Demo

- An airborne test pallet was developed to send ATN messages containing cockpit data
- The test pallet was installed in the NASA Lear Jet
- An antenna was added to the AGTS

Cockpit Security Demo

- ARINC/NASA/Teledyne developed test pallet
- Flight Data Recorder data subset
- Cockpit images and audio

Play audio 1
Play audio 2

The AGTS as a validation platform for weather applications

- A suggested area of study would be to combine the functionality of existing ACARS based weather applications such as FIS, TWIP and MDCRS into a single ATN application that can take advantage of the bandwidth of VDL Mode 2
- Both AOA and ATN data link applications can be tested
- Provides “real world” test and flight test demo platform
- Can be used with NASA’s Rockwell Collins avionics for laboratory and flight tests

Summary

- VDL Mode 2 has been selected worldwide as the first generation ATN data link for AOC and ATS
- VDL Mode 2 has been matured through rigorous testing
- ARINC's VDL Mode 2 AOA and ATN networks are operational today
- CPDLC Build 1 is operational in Miami ARTCC now
- AGTS is a high fidelity test environment for VDL Mode 2 application validation

Any Questions?